Experiment: Differential Amplifier with active load

Aim:

To implement a differential amplifier of gain 100 with active load and analyze its transient characteristics.

Tool Used:

LTspice

Theory:

Differential amplifiers apply gain not to one input signal but to the difference between two input signals. This means that a differential amplifier naturally eliminates noise or interference that is present in both input signals.

For a NMOS, PMOS let's assume

$V_T = 0.4V$

$V_{DD} = 1.8V$

$K_n = 120\mu A/V^2$,

$K_p = 120\mu A/V^2$,

Which implies

$r_{01} = 1/ \text{lambda}_n * I_D = 200Kohm$

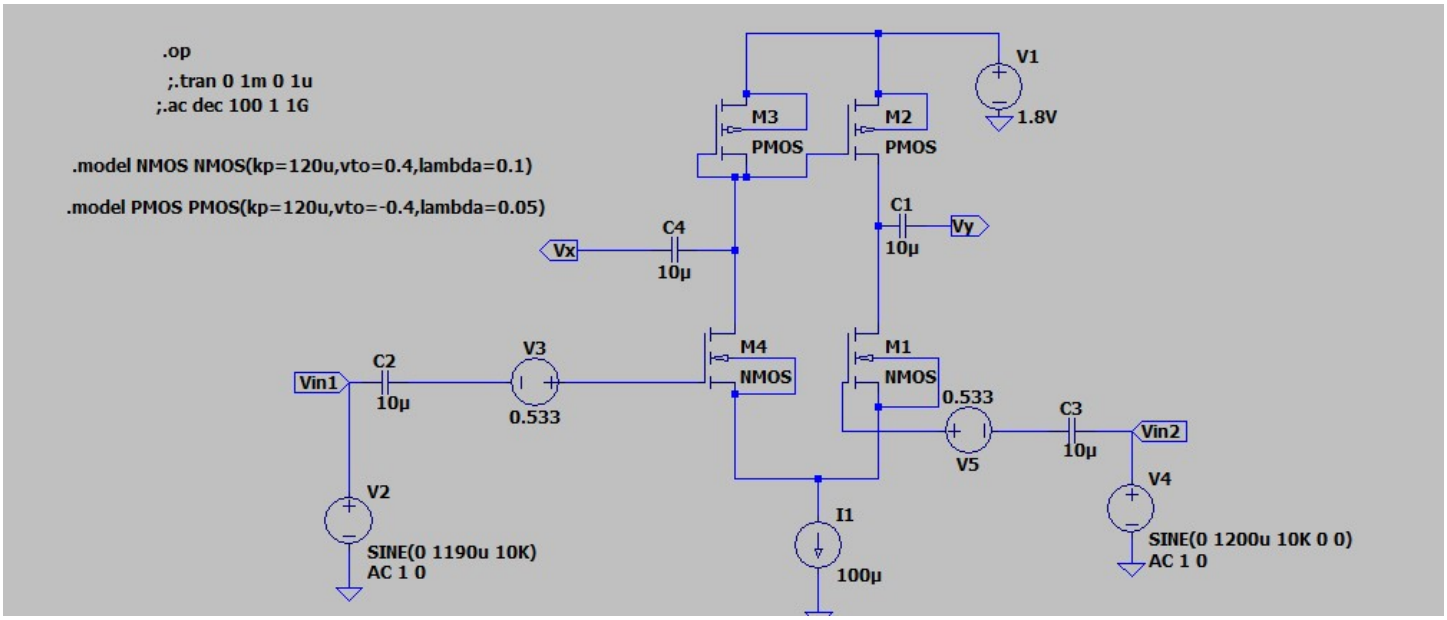
$r_{02} = 1/ \text{lambda}_p * I_D = 400Kohm$

Which gives the value of R_{out} to be 133.33 Kohm

Which gives a value of (W/L) = 46.8 for 50uA I_D.

Hence with this value of W/L we get a V_{GS} of 0.533V

Circuit Schematic:



Output Waveforms:

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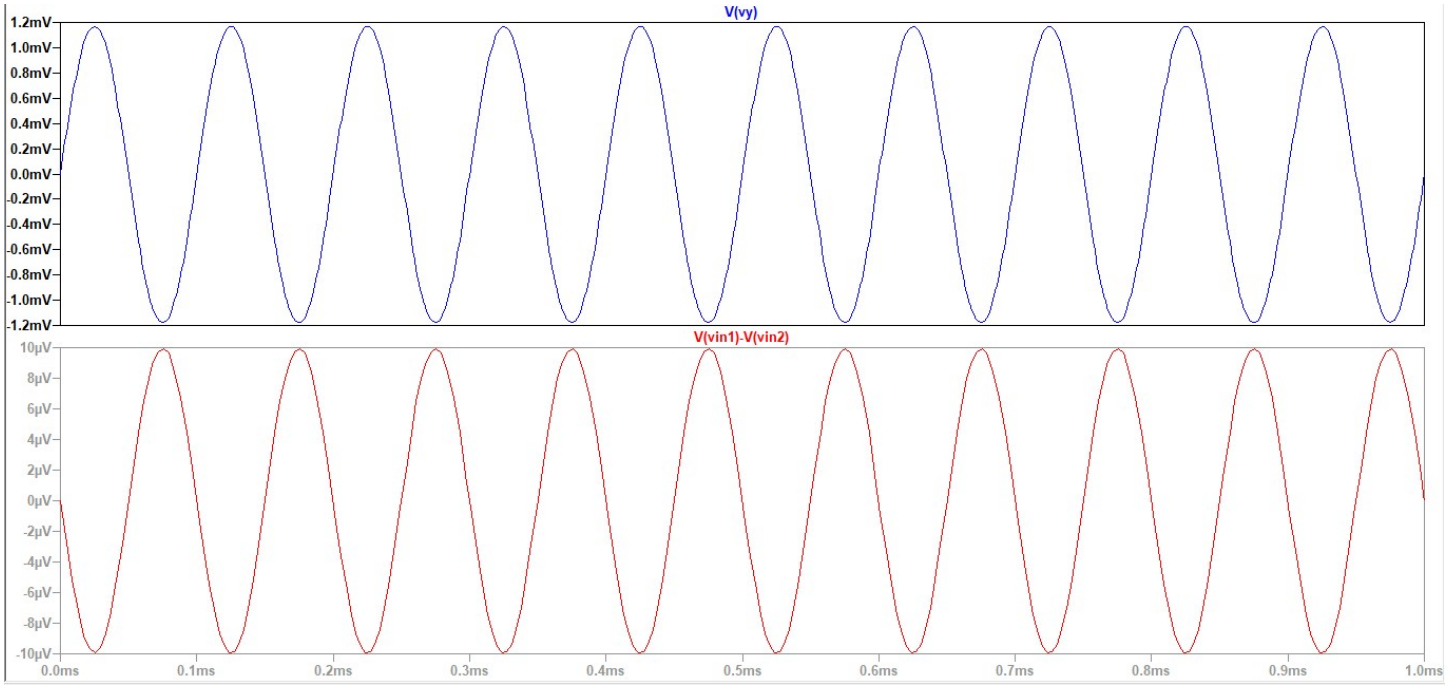
        --- Operating Point ---

V(n001):          1.8             voltage
V(n002):          0.525487        voltage
V(n003):          -0.51144        voltage
V(vy):            -5.11435e-006   voltage
V(n007):          0.533           voltage
V(n004):          -0.525412       voltage
V(vin1):          0               voltage
V(n005):          -0.532995       voltage
V(n006):          5.32995e-006    voltage
V(vin2):          0               voltage
V(n008):          0               voltage
V(vx):            5.25482e-006    voltage
Id(M4):           4.88105e-005    device_current
Is(M4):           -4.88105e-005   device_current
Id(M1):           5.11894e-005    device_current
Is(M1):           -5.11894e-005   device_current
Id(M3):           4.88105e-005    device_current
Is(M3):           -4.88105e-005   device_current
Id(M2):           5.11895e-005    device_current
Is(M2):           -5.11895e-005   device_current
I(C4):            5.25482e-018    device_current
I(C3):            0               device_current
I(C2):            -5.32995e-018   device_current
I(C1):            5.11435e-018    device_current
I(I1):            0.0001          device_current
I(V5):            0               device_current
I(V4):            0               device_current
I(V3):            -5.32995e-018   device_current
I(V2):            -5.32995e-018   device_current
I(V1):            -0.0001         device_current
```

Transient characteristics



Result:

The circuit is designed for a gain of 100 and the output is verified to be correct.